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Brzezniak et al.

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(54) **ADJUSTABLE KNOCKOUT ASSEMBLY FOR A PRESS SYSTEM**

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(52) **U.S. Cl.** **72/345**
(58) **Field of Search** 72/20.5, 344, 345, 72/427; 100/218

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,546,100	A	*	9/1951	Johansen et al.	72/450
4,096,728	A	*	6/1978	Glecker et al.	72/345
4,120,185	A	*	10/1978	Schneider et al.	72/20.5
4,242,901	A	*	1/1981	Pearson et al.	72/345

* cited by examiner

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(57) **ABSTRACT**

A press system having a frame, a slide, a first die element on the slide, and a knockout assembly. The slide is movable guidingly relative to the frame in a predetermined path between a first position and a second position. The first die element has a forming surface against which a workpiece can be borne to conform the workpiece to the forming surface as the slide is moved from the first position towards the second position. The knockout assembly has an ejecting element that is movable selectively relative to the first die element between extended and retracted positions. The ejecting element causes a workpiece conformed to the forming surface to be separated from the forming surface as an incident of the ejecting element moving from its retracted position into its extended position. The knockout assembly further includes a knockout bar and at least a first knockout pin. The knockout bar is movable relative to the slide between a retracted position and an extended position and causes the ejecting element to move from its retracted position into its extended position as an incident of the knockout bar moving from its retracted position and into its extended position. The at least first knockout pin causes the knockout bar to be moved from its retracted position into its extended position as an incident of the slide moving from the second position into the first position. The first knockout pin and the knockout bar have an operative relationship that is variable from a location remote from the first knockout pin.

22 Claims, 7 Drawing Sheets

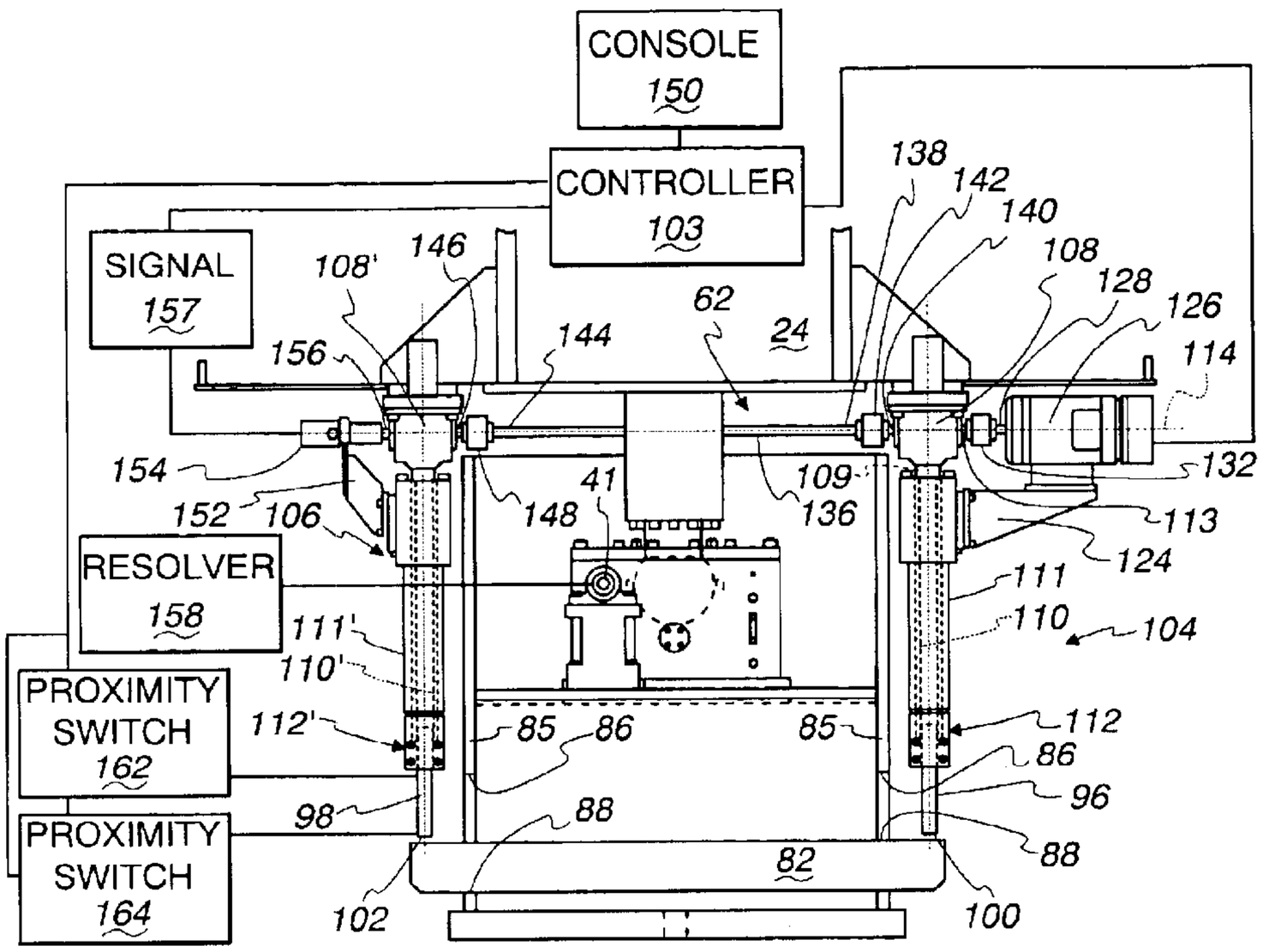
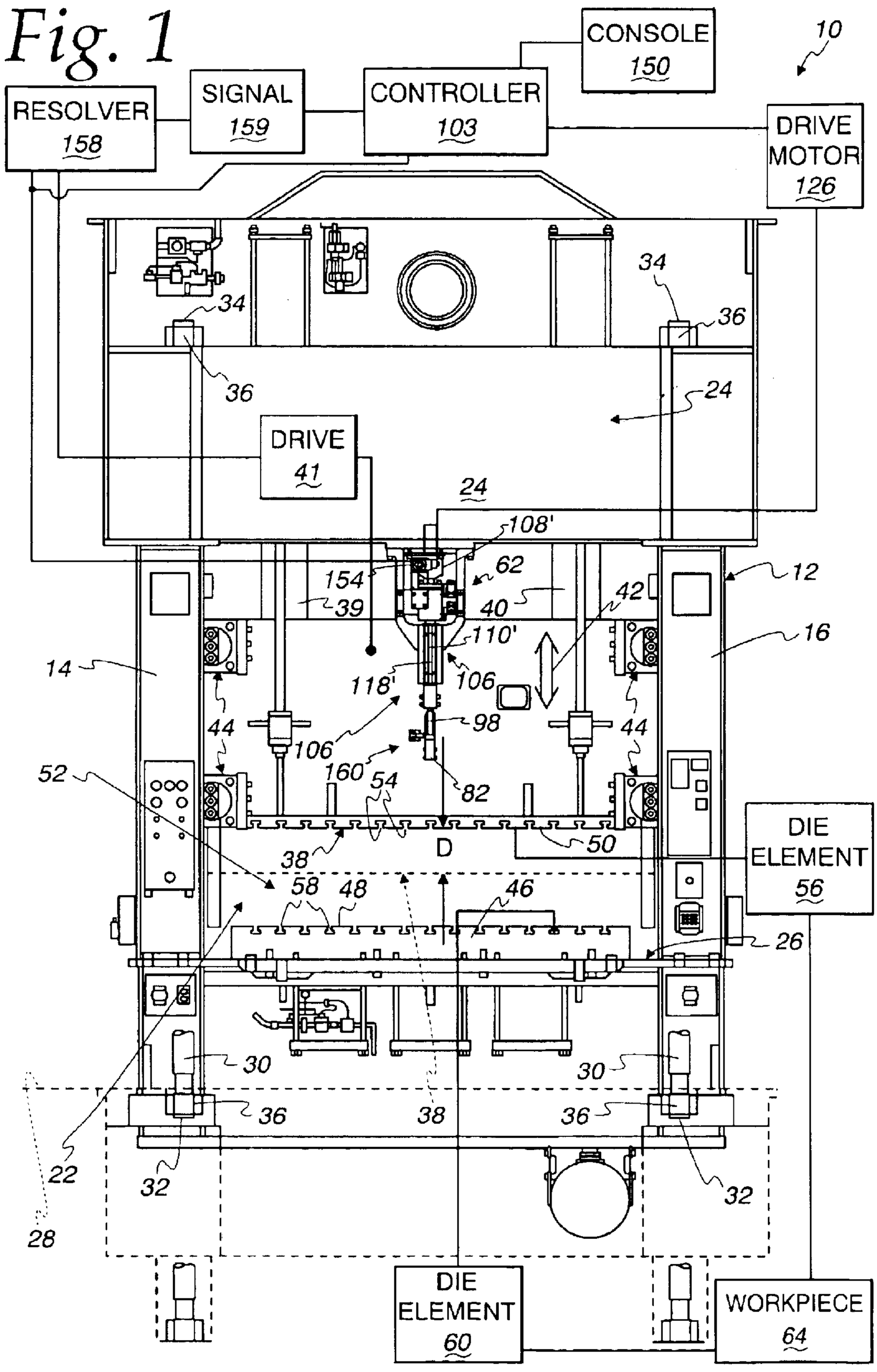


Fig. 1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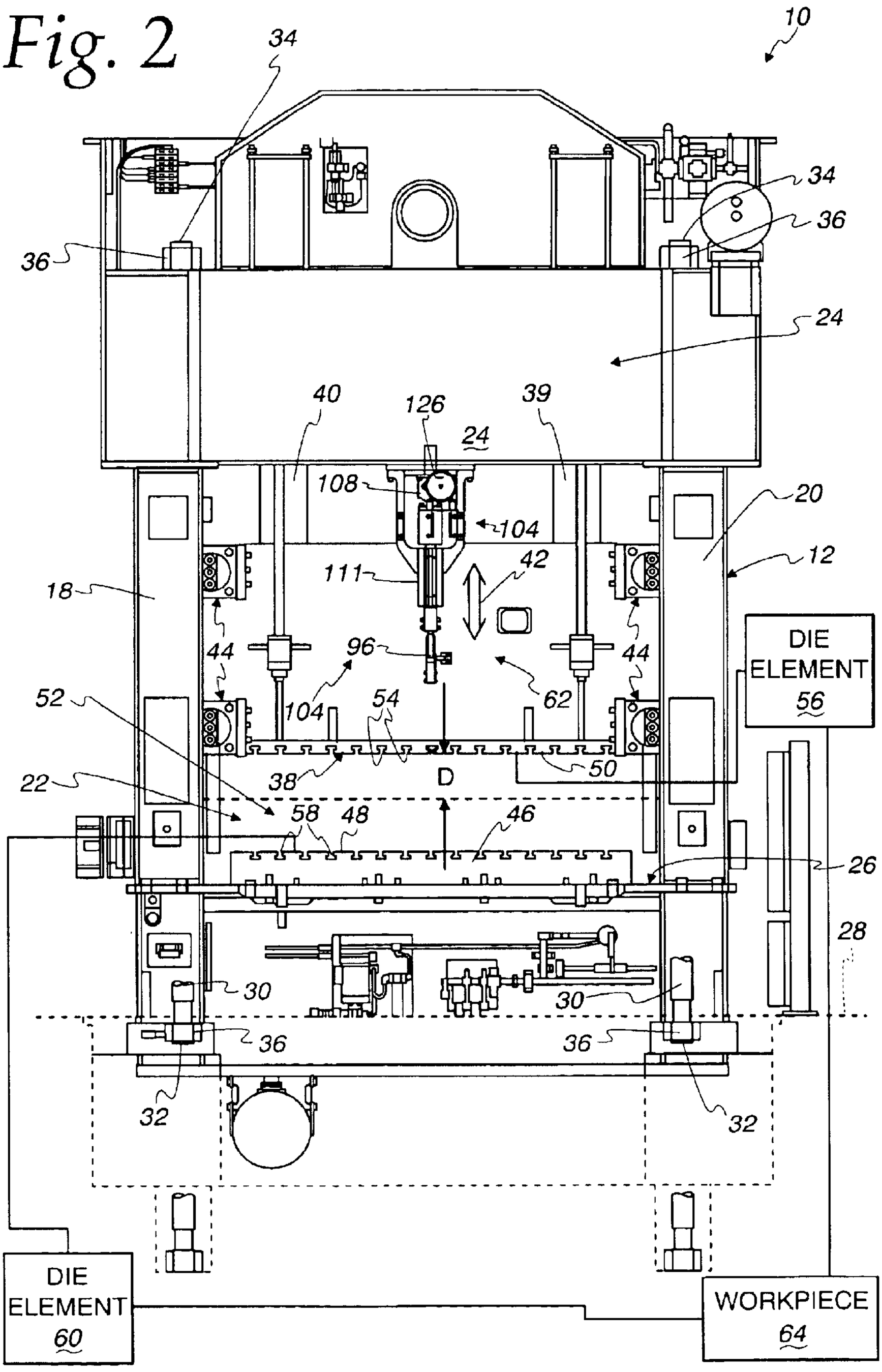
64

Fig. 2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DIE ELEMENT 60
WORKPIECE 64

Fig. 3

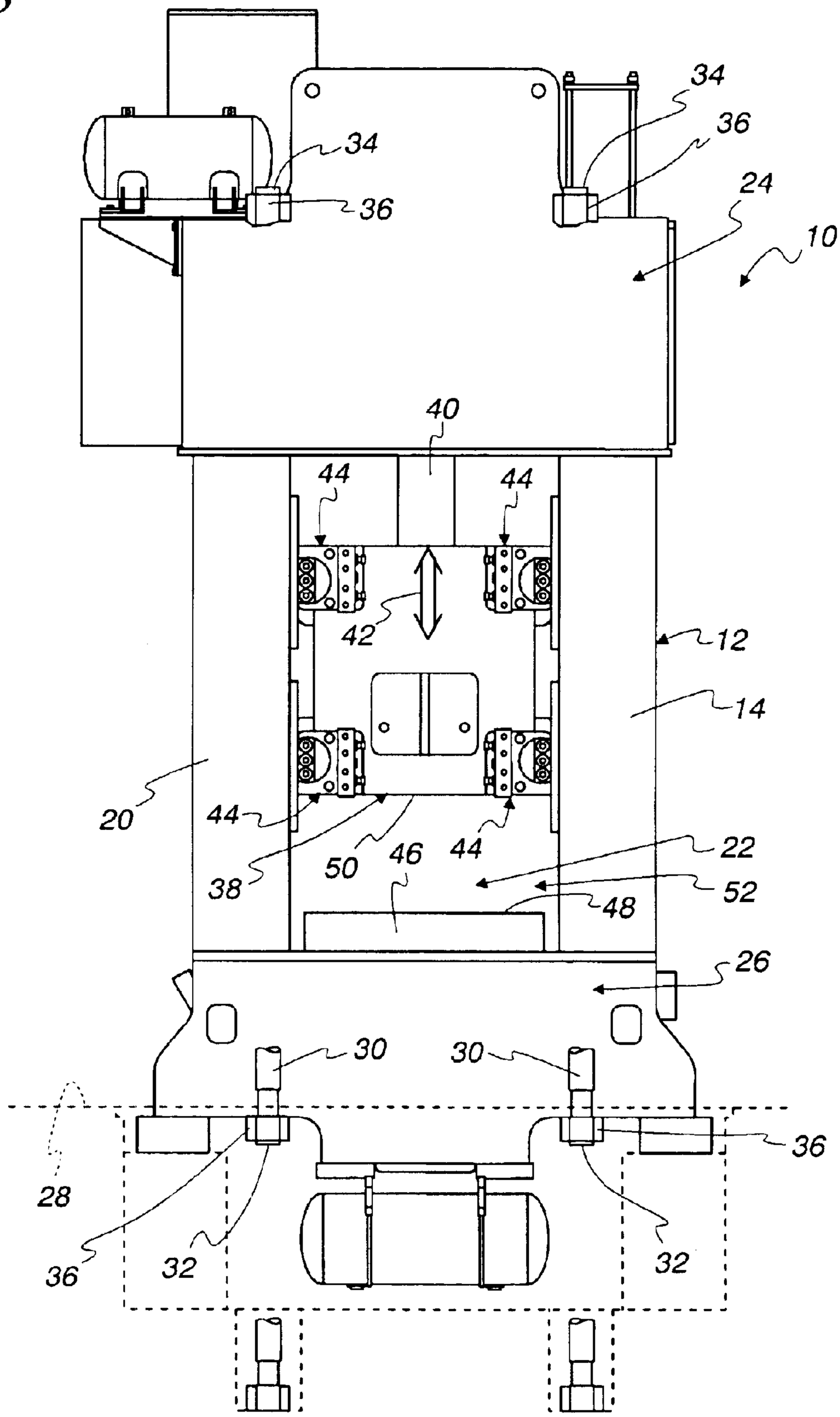
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Fig. 4

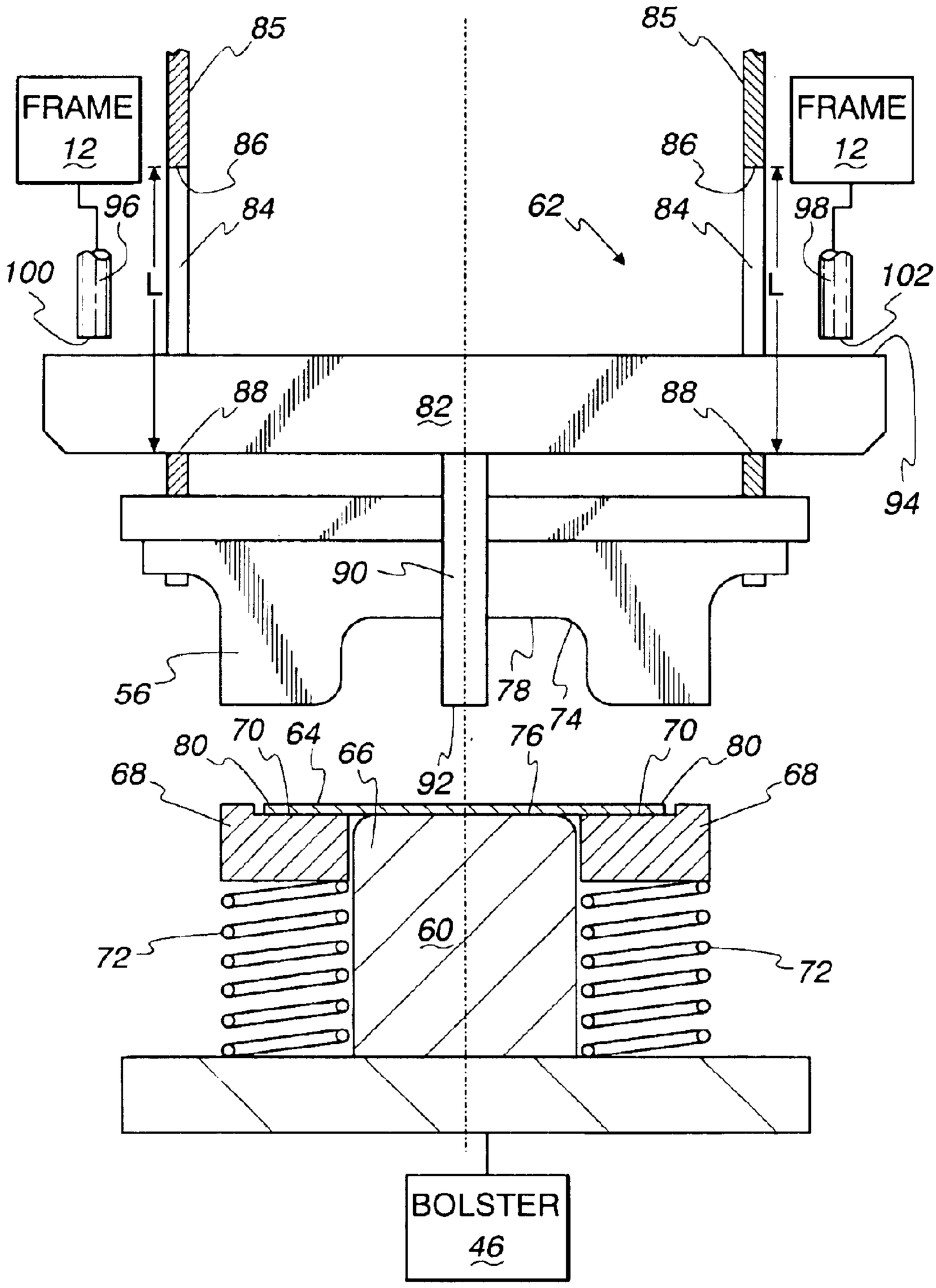
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Fig. 5

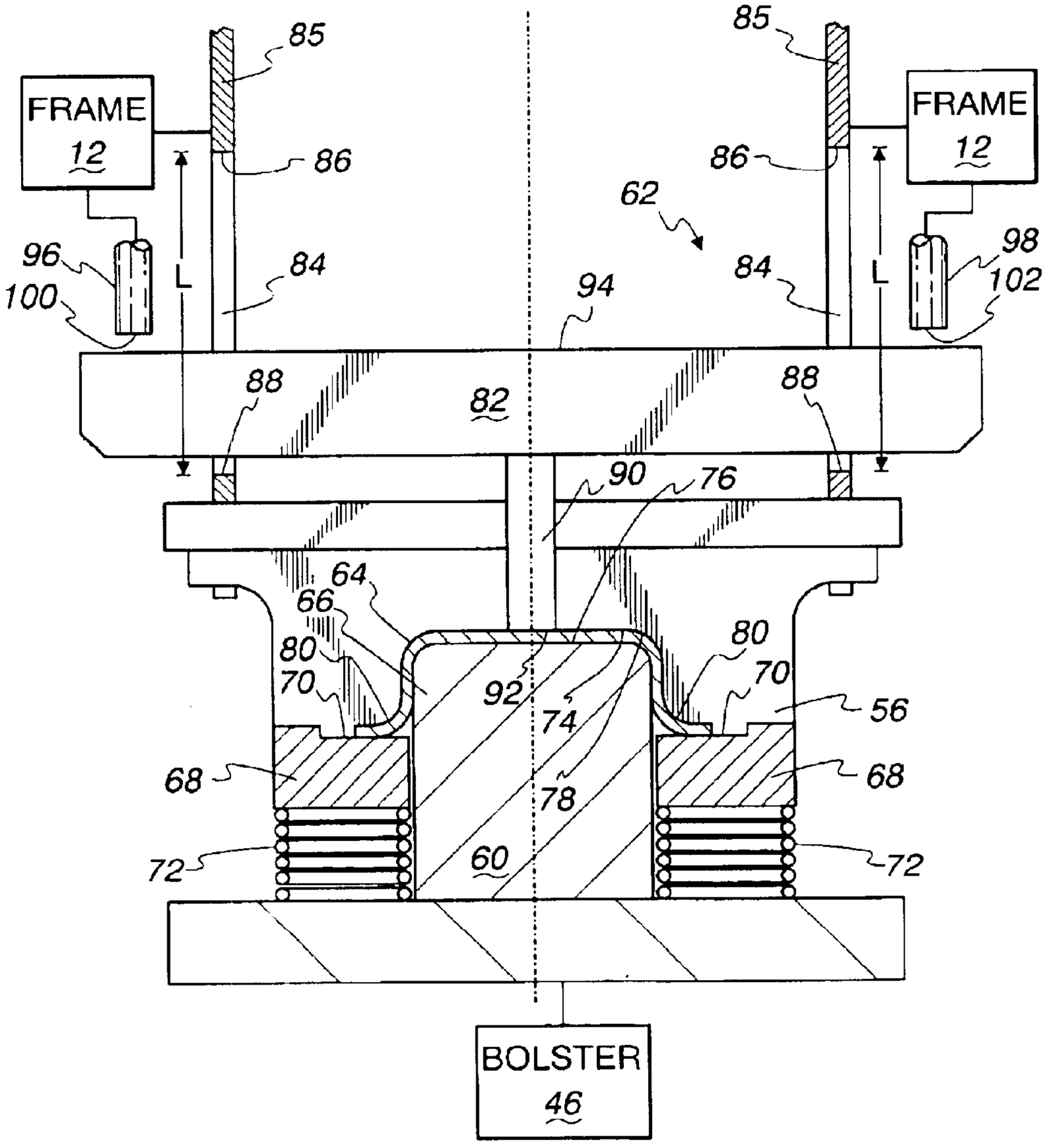
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Fig. 6

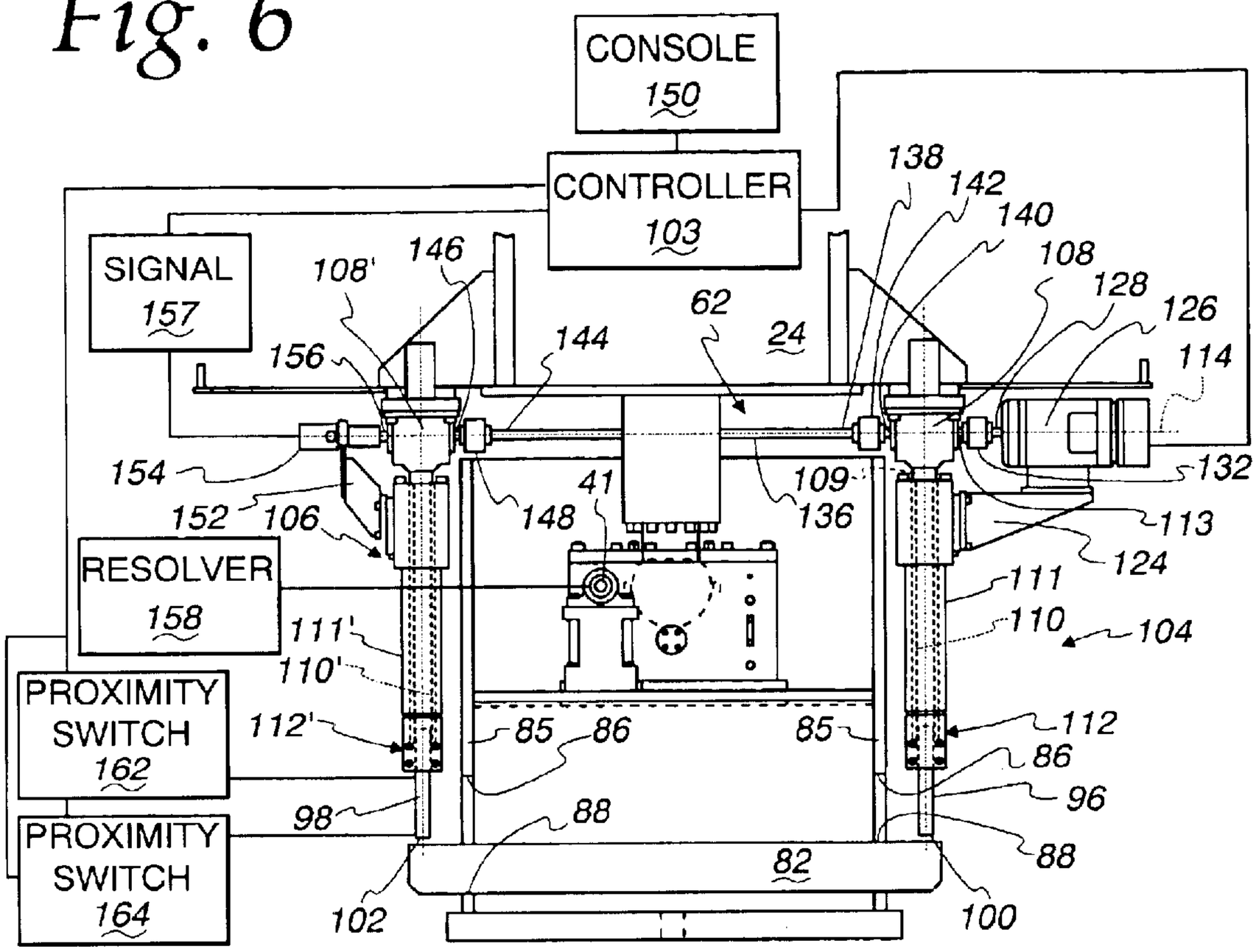
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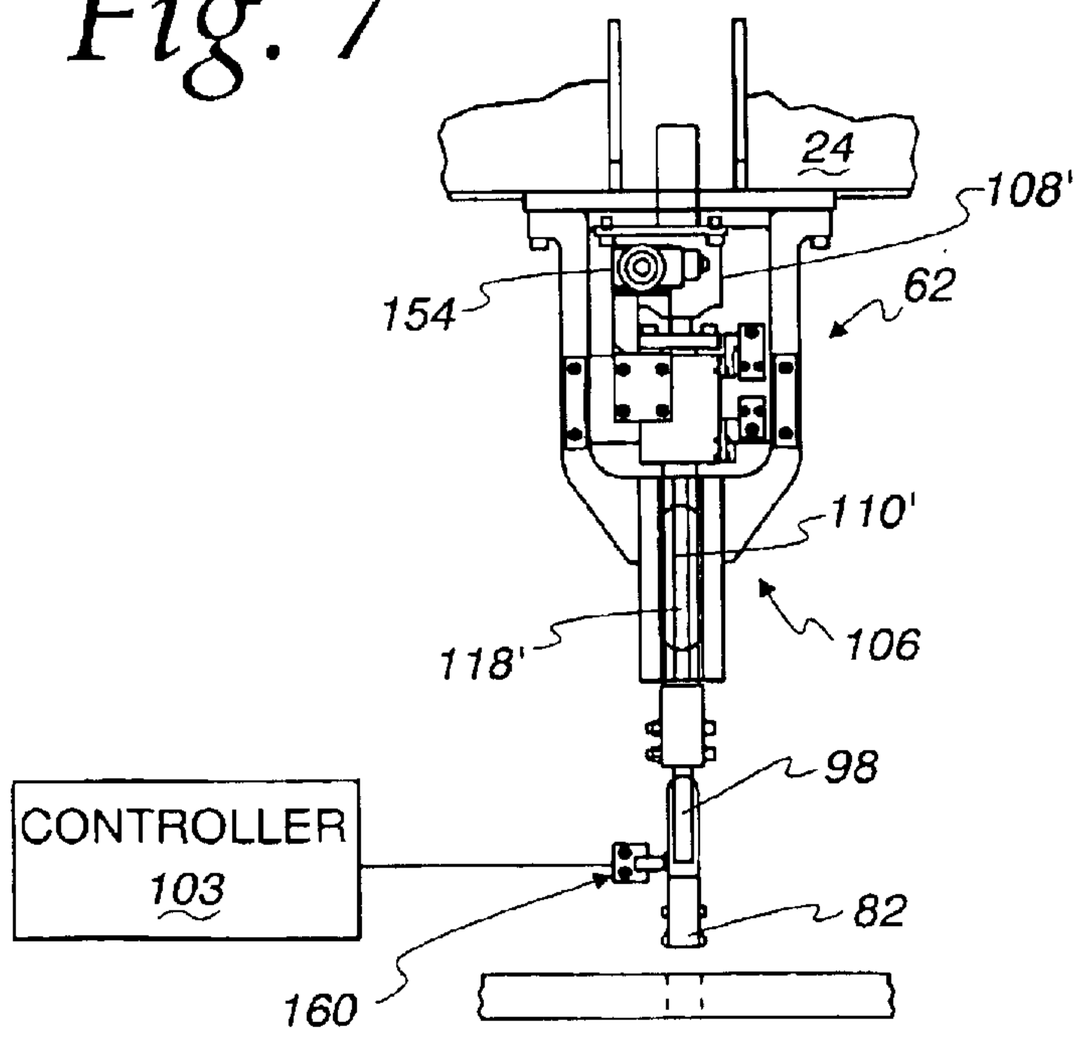
Fig. 7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CONTROLLER
103
82
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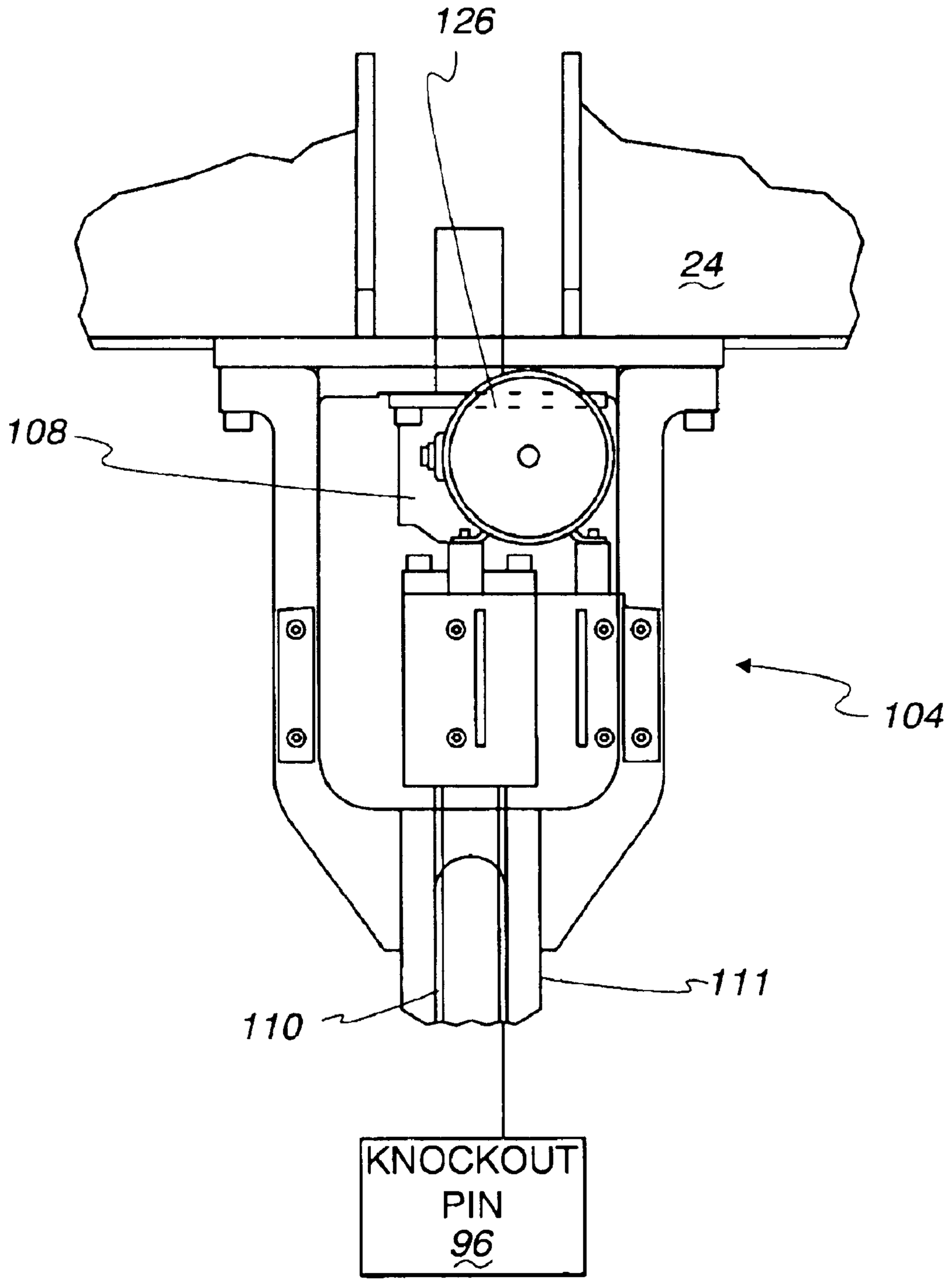
Fig. 8



ADJUSTABLE KNOCKOUT ASSEMBLY FOR A PRESS SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to press systems and, more particularly, to a knockout assembly for parts formed on a press system.

2. Background Art

Knockout assemblies are commonly used in parts forming presses to separate the parts from die surfaces against which the parts are formed. In an exemplary press system, a translatable die element is advanced in a predetermined path to cause a workpiece blank to be formed against a surface on the die element. The forming surface may have sufficient complexity that the part will not consistently release from against the forming surface without the application of a separation force. The separation force is typically imparted through a bar on a knockout assembly.

In one known knockout assembly construction, the knockout bar has an associated element which can be selectively a) advanced through the die element and past the forming surface with the knockout bar in an extended position and b) withdrawn therefrom with the knockout bar in a retracted position. The knockout bar follows movement of a slide, which is guided in translation from a starting/first position into a second position, as an incident of which a workpiece blank is forced conformingly against the forming surface on the die element on the slide. Upon completion of the slide stroke, the slide is returned to its first position. As the slide moves back towards its first position, spaced locations on the knockout bar encounter cantilevered knockout pins which arrest further movement of the knockout bar. Continued movement of the slide towards the first position with the knockout bar blocked causes the knockout bar to translate relative to the slide, as an incident of which the knockout bar is changed from its retracted position into its extended position and, in so doing, effects separation of the formed part from against the die element surface.

Conventionally, the knockout pins have been in the form of cantilevered elements with free ends which directly contact the knockout bar. Proper operation of a knockout assembly requires a specific spatial relationship between the knockout pins and the knockout bar. If the required relationship between the knockout bar and knockout pins is not maintained, a number of different conditions could result, which could either impair performance of, or cause damage to, the press.

One such condition occurs in the event that the knockout pins do not engage the knockout bar so as to maintain its intended orientation with respect to the slide. If the knockout pins skew the knockout bar, a misalignment of the knockout bar with the slide may result which could cause uneven wear on guidingly cooperating parts, jamming, or destruction of one or more parts on the slide and/or knockout assembly.

Another more serious condition may occur in the event that the movement of the slide fully into its first position does not coincide with the movement of the knockout bar to its extended position. That is, if the knockout bar achieves its fully extended position as the slide continues to move towards its first position, the slide may be forced against the knockout pins and frame, upon which the knockout pins are mounted, so as to cause damage to be inflicted thereto and/or to the knockout assembly.

To avoid the above conditions, it is known to allow for adjustment of the knockout pins. This adjustment is desirable not only from the standpoint of avoiding the above conditions, but also to permit the press system to be set up for the performance of different operations and/or to accommodate different workpiece dimensions requiring a different slide stroke.

Heretofore, knockout pins in this type of press system have been made adjustable through manual operations performed by a technician directly at the location of the knockout pins. In one such press system, the knockout pins are elongate elements with a separate piece at the ends thereof, each of which has a surface to directly engage a knockout bar. Each end piece is threadably connected to the remainder of its associated knockout pin. By rotating the end piece, the effective length of the knockout pin can be changed. This operation needs to be performed on each of the knockout pins on the system in such a manner that their length adjustment corresponds. The effective length of the knockout pins is determined by separately taking a measurement for each adjusted knockout pin.

This manual adjustment has a number of inherent drawbacks. First of all, the technician must walk directly upon the press system components to access the knockout pins. Oft times the knockout pins are located so as not to be conveniently accessible. There is always a danger that the technician may be injured during this process. Additionally, the adjustment process is time consuming. The technician is required to climb over the equipment to each of the separate knockout pins and, through a wrench or otherwise, make the necessary adjustments. Significant down time may result. Further, the on site measuring of the altered effective length of the knockout pins through a tape measure may be awkward and imprecise. This could ultimately result in one of the conditions that is described above.

With the manually adjusted system, the operator may have to periodically visually inspect the knockout pins to make certain that they are situated and operating properly. Fine adjustments may have to be made which necessitates shutting down of the press system and proceeding again with manual adjustment. This adjustment will normally be required at each die change. Die changes may be required frequently in press operations. A die change may take 45 minutes for a 15 minute run. Thus minimizing down time may become extremely important to press efficiency.

A further problem with the manual adjustment is that it may require a considerable amount of trial and error to make certain that the operative relationship between the slide, frame, knockout pins, and knockout bar is as desired. This process is inconvenient and time consuming as it may require several test adjustments and test runs before full operation is undertaken.

SUMMARY OF THE INVENTION

In one form, the invention is directed to a press system having a frame, a slide, a first die element on the slide, and a knockout assembly. The slide is movable guidingly relative to the frame in a predetermined path between a first position and a second position. The first die element has a forming surface against which a workpiece can be borne to conform the workpiece to the forming surface as the slide is moved from the first position towards the second position. The knockout assembly has an ejecting element that is movable selectively relative to the first die element between extended and retracted positions. The ejecting element causes a workpiece conformed to the forming surface to be

separated from the forming surface as an incident of the ejecting element moving from its retracted position into its extended position. The knockout assembly further includes a knockout bar and at least a first knockout pin. The knockout bar is movable relative to the slide between a retracted position and an extended position and causes the ejecting element to move from its retracted position into its extended position as an incident of the knockout bar moving from its retracted position and into its extended position. The at least first knockout pin causes the knockout bar to be moved from its retracted position into its extended position as an incident of the slide moving from the second position into the first position. The first knockout pin and the knockout bar have an operative relationship that is variable from a location remote from the first knockout pin.

In one form, the knockout bar is movable guidingly relative to the slide between its extended and retracted position.

In one form, the at least first knockout pin has a first surface. With the knockout bar in its retracted position and the slide in the second position, the first surface is spaced from the knockout bar a first distance. The operative relationship between the first knockout pin and the knockout bar is variable by changing the first distance.

In one form, the first knockout pin is part of a first knockout pin assembly. The first knockout pin assembly includes a selectively operable first advancing element for repositioning the first knockout pin relative to the frame so as to thereby selectively change the first distance. The knockout assembly further has a drive for operating the first advancing element.

In one form, the advancing element is a part of a screw jack that is operated by a motor.

In one form, as the slide is moved from the second position into the first position, the first surface of the first knockout pin comes into engagement with the knockout bar at a first location.

In one form, the knockout assembly includes a second knockout pin assembly with a second knockout pin. The second knockout pin has a second surface that is engageable with the knockout bar. With the knockout bar in its retracted position and the slide in the second position, the second surface is spaced from the knockout bar a second distance. The operative relationship between the second knockout pin and the knockout bar is variable from a location remote from the second knockout pin.

In one form, the second knockout pin assembly includes a selectively operable second advancing element for repositioning the second knockout pin relative to the frame so as to thereby selectively change the second distance.

In one form, the second advancing element is operated by the drive.

In one form, the first advancing element is a part of a first jack and the second advancing element is part of a second jack. The first and second jacks are interconnected so that operation of the first and second advancing elements is synchronized.

In one form, the first advancing element can be adjusted independently of the second advancing element.

The press system may further include at least a first sensor for detecting at least one of a) a first relationship between the first knockout pin and the frame; and b) a second relationship between the first knockout pin and the knockout bar with the first knockout pin and knockout bar positioned relative to each other and the frame in a predetermined manner, and causing the production of signals indicative of the first and second relationships.

The press system may further include a controller for receiving the signals from the at least first sensor.

The press system may further include a drive that is operable through the controller to selectively change the first and second relationships.

In one form, the press system further includes at least a first resolver which generates signals to the controller useable to automatically maintain a selected first and second relationships through the controller.

The press system may further include at least a second sensor for detecting a third relationship between the slide and the frame and causing the production of signals to the controller indicative of the third relationship.

The press system may further include a second resolver which generates signals to the controller useable to automatically maintain a selected third relationship through the controller.

The invention is further directed to a press system including a frame, a slide, a first die element, and a knockout assembly. The slide is movable guidingly relative to the frame in a predetermined path between a first position and a second position. The first die element has a forming surface against which a workpiece can be borne to conform the workpiece to the forming surface as the slide is moved from the first position toward the second position. The knockout assembly has an ejecting element that is movable selectively relative to the first die element between extended and retracted positions. The ejecting element causes a workpiece conformed to the forming surface to be separated from the forming surface as an incident of the ejecting element moving from its retracted position into its extended position. The knockout assembly further includes a knockout bar and at least a first knockout pin. The knockout bar is movable relative to the slide between a retracted position and an extended position and causes the ejecting element to move from its retracted position into its extended position as an incident of the knockout bar moving from its retracted position into its extended position. The at least first knockout pin causes the knockout bar to be moved from its retracted position into its extended position as an incident of the slide moving from the second position into the first position. The knockout assembly further includes a powered drive. The at least first knockout pin and the knockout bar have an operative relationship that is variable by operating the powered drive.

The invention is further directed to a method of operating a press of the type described above, wherein the method includes the step of selectively varying the operative relationship between the first knockout pin and the knockout bar through a controller.

The method may further include the steps of generating signals indicative of the operative relationship between the first knockout pin and knockout bar and monitoring the operative relationship between the first knockout pin and the knockout bar through the signals.

The method may further include the steps of selecting a desired operative relationship between the first knockout pin and knockout bar through the controller, monitoring the operative relationship and producing signals indicative of the operative relationship, and through the controller processing the signals and in response thereto causing variation in the operative relationship between the first knockout pin and knockout bar necessary to maintain the desired operative relationship.

The method may further include the steps of monitoring an operative relationship between the slide and the frame and causing the production of signals to the controller indicative of the operative relationship between the slide and the frame.

The method may further include the steps of selecting a desired operative relationship between the slide and the frame, monitoring the operative relationship and producing signals indicative of the operative relationship, and through the controller processing the signals and thereby causing any necessary variation in the operative relationship between the slide and the frame to maintain the desired operative relationship between the slide and frame.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front elevation view of a press system incorporating a knockout assembly for separating formed workpieces from a die element, according to the present invention;

FIG. **2** is a rear elevation view of the press system in FIG. **1**;

FIG. **3** is a left side elevation view of the press system in FIGS. **1** and **2**;

FIG. **4** is a schematic representation of the press system in FIGS. **1–3** and showing cooperating die elements in a position preparatory to workpiece formation;

FIG. **5** is a view as in FIG. **4** with the die elements situated to fully form the workpiece;

FIG. **6** is an enlarged, fragmentary, side elevation view of the inventive knockout assembly on the press system in FIGS. **1–3**;

FIG. **7** is an enlarged, fragmentary, front elevation view of the inventive knockout assembly; and

FIG. **8** is an enlarged, fragmentary, rear elevation view of a screw jack for adjusting a knockout pin on the inventive knockout assembly.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring initially to FIGS. **1–3**, a press system with the present invention incorporated therein, is shown at **10**. It is necessary to understand only the general operation of the press system **10** as one representative environment for the present invention. The inventive structure could be utilized in press systems having configurations substantially different than that of the press system **10** shown.

Briefly, the press system **10** consists of a frame **12** having four vertically extending, elongate columns **14, 16, 18, 20** which bound an operating space **22**. The columns **14, 16, 18, 20** extend, and connect, between an overhead crown assembly **24** and a bed assembly **26**, with the latter being implanted through a support surface **28**. The columns **14, 16, 18, 20**, crown assembly **24**, and bed assembly **26** are united through tie rods **30**, each extending through a column **14, 16, 18, 20**, the crown assembly **24**, and the bed assembly **26**, so that opposite, threaded rod ends **32, 34** are exposed at the bed assembly **26** and crown assembly **24**, respectively, so as to accept a nut **36**. By tightening the nuts **36**, a unitary assembly, with the columns **14, 16, 18, 20** captive between the crown assembly **24** and the bed assembly **26**, results.

A slide/slide assembly **38** is suspended from the crown assembly **24** by two connecting rods **39,40**. The connecting rods **39,40** have lower ends (not shown) which are attached to the slide assembly **38** at spaced locations through connections that permit guided, universal, movement between the lower end of each rod **39, 40** and the slide assembly **38**. The manner of vertically repositioning the slide assembly **38** is likewise not important to the present invention. Virtually any known mechanism can be used to change the slide assembly **38** between a first/raised position, as shown in solid lines in FIGS. **1–3**, and a second/lowered position, shown in dotted lines in FIG. **1**. The distance D between the solid and dotted line positions for the slide assembly **38** represents the slide assembly stroke length for a particular application. The stroke length/distance D shown is intended only to be representative in nature. While the press stroke is not variable in the press system **10** shown, press systems are well known in which the stroke is variable so that the stroke may be changed depending upon the dimensions of a workpiece to be processed and the nature of the processing to be carried out.

Through a main drive **41** on the crown assembly **24**, as shown schematically in FIG. **1**, the slide assembly **38** is selectively raised and lowered through the connecting rods **39, 40**, moving guidingly against the frame **12** vertically upwardly and downwardly, as indicated by the double-headed arrow **42**. The slide assembly **38** is guided in vertical movement by the columns **14, 16, 18, 20** at the four comers of the slide assembly **38**. At the top and bottom of each corner, a guide assembly **44**, each of the same construction, is provided. The guide assemblies **44** are described in greater detail in copending application Ser. No. 101002,731, the disclosure of which is incorporated herein by reference.

A bolster **46** is mounted to the bed assembly **26** so as to situate an upwardly facing, flat, mounting surface **48** substantially parallel to a downwardly facing, flat mounting surface **50** at the bottom of the slide assembly **38**. The flat surfaces **48, 50** cooperatively bound a die operating space **52**. The slide assembly **38** has a series of parallel, T-shaped, elongate, fore-and-aft slots **54** formed through the surface **50** thereon to accommodate conventional, complementary structure for mounting to the slide assembly **38** a die element **56**. The bolster **46** has similar, parallel slots **58** that are complementary to the mounting structure on a separate, cooperating die element **60**.

The present invention is concerned with a knockout assembly at **62** which functions to expel a workpiece **64**, formed by cooperation between the die elements **56,60** as the slide assembly **38** moves from the first/raised position into the second/lowered position, that tends to adhere to the die element **56**, thereby following movement of the retracting slide assembly **38**.

Referring now to FIGS. **4** and **5**, a schematic representation of the knockout assembly **62** and die elements **56, 60** is shown to facilitate a general explanation of the operation of these structures. The die element **60** has a projection **66** adjacent to which cushioning pads **68** are placed. The cushioning pads **68** each have an undercut, upwardly facing, upper surface **70** and are urged normally upwardly by biasing mechanisms/springs **72**. The die element **56** has a cavity **74** that is complementary to the shape of the outer forming surface **76** of the projection **64** on the die element **60**. The workpiece blank **64** is initially placed between the die elements **56, 60**, as upon the projection **66**. By advancing the slide assembly **38** downwardly from the first/raised position towards the second/lowered position, a forming surface **78**, bounding the cavity **74** which receives the projection **66**, bears upon the workpiece blank **64** and progressively causes the workpiece blank **64** to conform to the complementary forming surfaces **76, 78** of the die elements **60, 56**, respectively. With the slide assembly **38** fully lowered to its second position, the workpiece blank **64**

assumes the shape shown in FIG. **5**. The edges **80** of the workpiece blank **62** nest against the undercut surfaces **70** on the cushioning pads **68**. The cushioning pads **68** maintain the edges **80** substantially horizontally oriented as the workpiece blank **64** is wrapped conformingly against the projection **66**. Of course, it should be kept in mind that the particular workpiece formation that is shown is intended only to be illustrative, as any press forming process with virtually any type of die element or elements is contemplated.

Once the workpiece blank **64** is formed to the FIG. **5** shape, the slide assembly **38** can be raised towards its first position. As this occurs, the biased cushioning pads **68** maintain the formed workpiece **64** pressed upwardly against the surface **78** of the upper die element **56** so that the workpiece **64** separates **20** from the projection **66**. Depending upon the shape of the cavity **74**, during retraction of the slide assembly **38**, the formed workpiece blank **64** may either release from the die element **56** or become wedged therein so as to continue to follow the upward movement of the die element **56** as the slide assembly **38** is raised.

The knockout assembly **62** is constructed so as to expel the formed workpiece **64** from the cavity **74** as an incident of the slide assembly **38** retracting towards its first position and carrying the die element **56** with the formed workpiece **64** therewith. The knockout assembly **62** consists of knockout bar **82** which moves guidingly within a slot **84** through spaced legs **85** on the slide assembly **38**. The slot **84** has a vertical dimension L in each leg **85** bound by downwardly and upwardly facing edges **86**, **88** which respectively limit upward and downward translational movement of the knockout bar **82**.

The knockout bar **82** has an associated ejecting element **90** which follows movement of the knockout bar **82**. With the slide assembly **38** in the FIG. **4** position, i.e., at or near the first position, the knockout bar **82**, under its own weight and that of the ejecting element **90**, moves downwardly into its extended position wherein the knockout bar **82** bears on the upwardly facing edges **88**. In the extended position for the knockout bar **82**, the ejecting element **90** projects through the die element **56** and past the forming surface **78**. As the slide assembly **38** continues downwardly from its FIG. **4** position towards its second, lowered position, the bottom **92** of the ejecting element **90** encounters the workpiece **64** that is bearing upon the upwardly facing portion of the forming surface **76**. Continued downward movement of the slide assembly **38** causes the ejecting element **90** and knockout bar **82** to be pressed upwardly to a point that the bottom **92** of the ejecting element **90** becomes flush with the forming surface **78** so as not to interfere with the formation of the workpiece **64**. The forming process for the workpiece **64** is completed upon the slide assembly **38** nearing or reaching the second position therefor. The slide assembly **38** is thereafter retracted, being moved upwardly towards its first position. As this upward movement continues, the upper edge **94** of the knockout bar **82** encounters a pair of spaced knockout pins **96**, **98** which are supported upon the frame **12**. As explained in greater detail hereinafter, the knockout pins **96**, **98** are adjustable to change the vertical position of downwardly facing surfaces **100**, **102** on the knockout pins **96**, **98**, respectively, relative to the frame **12**, and thereby the operative relationship of the knockout pins **96**, **98** and knockout bar **82**. The adjustment is effected so that the ejection of the workpieces **64** is accomplished without permitting the knockout pins **96**, **98** to engage the knockout bar **82** with the knockout bar **82** bearing upon the upwardly facing edge **88**. This avoids damage to the knockout pins **96**, **98**, the knockout bar **82**, and the slide assembly **38**.

Traditionally, the pickup pins **96**, **98** are adjusted manually, one by one, at their site by a technician to vary the vertical position of the surfaces **100**, **102** relative to the frame **12**. The vertical adjustment is required to avoid a "crash" situation, described above, and to ensure the required ejecting movement of the knockout bar **82** and ejecting element **90** as the slide assembly **38** is moved from its second position towards its first position after the formation of the workpiece **64**.

According to the invention, the vertical location of the surfaces **100**, **102** of the knockout pins **96**, **98** is monitored and adjusted through a controller **103**, as shown in FIGS. **1**, **2** and **6–8**. The knockout assembly **62** consists of a first knockout pin assembly **104** and a second knockout pin assembly **106**, each depending from the crown assembly **24**. The first knockout pin assembly **104** consists of a first screw jack **108** mounted to the crown assembly **24** and having a first vertically movable element **109** for repositioning the knockout pin **96**. One suitable screw jack is Duff-Norton's Model No. 9015 worm gear operated screw jack. The movable element **109** on the screw jack **108** is connected to, and vertically drives, a hollow guide tube **110** that slides within a bracket/guide sleeve **111** on the frame **12**. The lower end of the guide tube **110** is secured to the knockout pin **96** through a clamp assembly at **112**. By rotating an input element **113** on the screw jack **108** about an axis **114**, the guide tube **110**, and the knockout pin **96** attached thereto, are moved guidingly vertically to thereby cause the knockout pin **96** to change between its extended and retracted positions. A bracket **124** is cantilever mounted to the guide sleeve **111** and supports a drive motor **126** for operating the screw jack **108**. The motor shaft **128** is connected to the input element **113** on the screw jack **108** through a flexible coupling **132**.

The second knockout pin assembly **106** has a similar construction to the first knockout pin assembly **104**, with a second screw jack **108'** from which a second bracket/guide sleeve **111'** depends. The guide sleeve **111'** guides vertical translatory movement of a guide tube **110'**, to which the knockout pin **98** is attached through a clamp assembly **112'**, between extended and retracted positions.

The screw jacks **108**, **108'** are operatively interconnected for synchronous operation by a drive shaft **136**. The drive shaft **136** has one end **138** connected to an output shaft **140** on the first screw jack **108** through a flexible coupling **142** and an opposite end **144** connected to an input shaft **146** on the second screw jack **108'** through a flexible coupling **148**. By operating the drive motor **126**, the knockout pins **96**, **98** can be simultaneously extended and retracted through an adjustment range that may be on the order of six inches. A drive motor **126** of approximately one horsepower capacity may be suitable for this purpose. The drive motor **126** is selectively operable through the controller **103**. The operator may program and operate the controller **103** through a console **150** spaced at a convenient location remote from the knockout pins **96**, **98**.

A mounting bracket **152** is cantilever mounted to the guide sleeve **111'** and supports a resolver **154** which attaches to an output shaft **156** on the second screw jack **108'**. The resolver **154** determines the degree of angular movement of the output shaft **156**, which can be correlated to a vertical movement of the knockout pins **96**, **98**. A monitoring signal **157** from the resolver **154** can be communicated to the controller **103**. A the console **150**, using the data generated by the signal **157**, the operator can monitor the position of the knockout pins **96**, **98** and make an appropriate adjustment thereto. Preferably, it is also possible to independently

operate the screw jacks **108**, **108'** and to monitor their operation, i.e., the position of the knockout pins **96**, **98**, at the console **150** to make this independent adjustment therefrom.

As shown in FIG. **1**, a separate resolver **158** can be operatively connected to a rotary element associated with the drive **41** to produce a signal **159** that allows conversion of the drive operation into vertical positional data through the controller **103**. Accordingly, the position of the slide assembly **38** can be monitored and adjusted from the console **150**. With this arrangement, by having the resolvers **154**, **158** communicating with each other and the controller **103**, the operative relationships between a) the slide assembly **38** and the knockout pins **96**, **98**, b) the knockout pins **96**, **98** and the frame **12**, and c) the slide assembly **38** and the frame **12** can be monitored and adjusted through the console **150** and controller **103** for fully automatic operation of the knockout assembly **62** from a remote location without requiring direct access to the knockout assembly **62** by a technician.

Another aspect of the invention is the incorporation of a safeguard against a collision between the knockout bar **82** and the knockout pins **96**, **98** with the slide assembly **38** in its first position. i.e., top dead center, as shown in FIGS. **6** and **7**. To accomplish this, a proximity switch at **160** (FIG. **7**) detects the relationship between the knockout bar **82** and the knockout pin **98**. The proximity switch **160** generates a signal to the controller **103** which can be usable to maintain a desired spacing between the knockout pin **98** and the knockout bar **82** in the relative position shown in FIGS. **6** and **7**.

Further, as shown in FIG. **6**, proximity switches **162**, **164** can be utilized to calibrate the maximum raised and lowered positions, respectively, for one or both of the knockout pins **96**, **98**. The maximum raised position may be set to avoid potential damage inflicted through automatic or manual slide adjustment.

The invention permits system adjustments during a die change sequence and monitoring and adjustment during operation from the console **150**.

The foregoing disclosure of specific embodiments is intended to be illustrative of the broad concepts comprehended by the invention.

What is claimed is:

1. A press system comprising:

a frame;

a slide that is movable guidingly relative to the frame in a predetermined path between a first position and a second position;

a first die element on the slide and having a forming surface against which a workpiece can be borne to conform the workpiece to the forming surface as the slide is moved from the first position towards the second position; and

a knockout assembly comprising an ejecting element that is movable selectively relative to the first die element between extended and retracted positions,

the ejecting element causing a workpiece conformed to the forming surface to be separated from the forming surface as an incident of the ejecting element moving from the retracted position into the extended position,

the knockout assembly further comprising a knockout bar and at least a first knockout pin,

the knockout bar movable relative to the slide between a retracted position and an extended position and causing the ejecting element to move from its retracted position into its extended position as an incident of the knockout bar moving from its retracted position into its extended position,

the at least first knockout pin causing the knockout bar to be moved from its retracted position into its extended position as an incident of the slide moving from the second position into the first position,

the first knockout pin and the knockout bar having an operative relationship that is variable from a location remote from the first knockout pin,

wherein the knockout bar is movable guidingly relative to the slide between its extended and retracted positions,

wherein the at least first knockout pin has a first surface, with the knockout bar in its retracted position and the slide in the second position the first surface is spaced from the knockout bar a first distance, and the operative relationship between the first knockout pin and the knockout bar is variable by changing the first distance.

2. The press system according to claim **1** wherein the first knockout pin is part of a first knockout pin assembly, the first knockout pin assembly comprises a selectively operable first advancing element for repositioning the first knockout pin relative to the frame so as to thereby selectively change the first distance, and the knockout assembly further comprises a drive for operating the first advancing element.

3. The press system according to claim **1** wherein the advancing element is part of a screw jack that is operated by a motor.

4. The press system according to claim **1** wherein as the slide is moved from the second position into the first position the first surface of the first knockout pin comes into engagement with the knockout bar at a first location.

5. The press system according to claim **1** wherein the knockout assembly comprises a second knockout pin assembly with a second knockout pin, the second knockout pin has a second surface that is engageable with the knockout bar, with the knockout bar in its retracted position and the slide in the second position the second surface is spaced from the knockout bar a second distance, and the second knockout pin and the knockout bar have an operative relationship that is variable from a location remote from the second knockout pin.

6. The press system according to claim **5** wherein the second knockout pin assembly comprises a selectively operable second advancing element for repositioning the second knockout pin relative to the frame so as to thereby selectively change the second distance.

7. The press system according to claim **6** wherein the second advancing element is operated by the drive.

8. The press system according to claim **6** wherein the first advancing element is a part of a first jack and the second advancing element is a part of a second jack and the first and second jacks are interconnected so that operation of the first and second advancing elements is synchronized.

9. The press system according to claim **8** wherein the first advancing element can be adjusted independently of the second advancing element.

10. The press system according to claim **1** further comprising at least a first sensor for detecting at least one of: a) a first relationship between the first knockout pin and the frame; and b) a second relationship between the first knockout pin and the knockout bar with the first knockout pin and knockout bar positioned relative to each other and the frame in a predetermined manner and causing the production of signals indicative of the first and second relationships.

11. The press system according to claim **10** further comprising a controller for receiving the signals from the at least first sensor.

12. The press system according to claim 11 further comprising a drive that is operable through the controller to selectively change the first and second relationships.

13. The press system according to claim 12 further comprising at least a first resolver which generates signals to the controller usable to automatically maintain a selected first and second relationship through the controller.

14. The press system according to claim 13 further comprising at least a second sensor for detecting a third relationship between the slide and the frame and causing the production of signals to the controller indicative of the third relationship.

15. The press system according to claim 14 further comprising at least a second resolver which generates signals to the controller useable to automatically maintain a selected third relationship through the controller.

16. A press system comprising:

a frame;

a slide that is movable guidingly relative to the frame in a predetermined path between a first position and a second position;

a first die element on the slide and having a forming surface against which a workpiece can be borne to conform the workpiece to the forming surface as the slide is moved from the first position towards the second position; and

a knockout assembly comprising an ejecting element that is movable selectively relative to the first die element between extended and retracted positions,

the ejecting element causing a workpiece conformed to the forming surface to be separated from the forming surface as an incident of the ejecting element moving from the retracted position into the extended position,

the knockout assembly further comprising a knockout bar and at least a first knockout pin,

the knockout bar movable guidingly relative to the slide between a retracted position and an extended position and causing the ejecting element to move from its retracted position into its extended position as an incident of the knockout bar moving from its retracted position into its extended position,

the at least first knockout pin causing the knockout bar to be moved from its retracted position into its extended position as an incident of the slide moving from the second position into the first position,

the knockout assembly further comprising a powered drive,

the at least first knockout pin and the knockout bar having an operative relationship that is variable by operating the powered drive,

wherein the at least first knockout pin has a first surface, with the knockout bar in its retracted position and the slide in the second position the first surface is spaced from the knockout bar a first distance, and the operative relationship between the first knockout pin and the knockout bar is variable by changing the first distance.

17. A method of operating a press system of the type comprising; a frame; a slide that is movable guidingly relative to the frame in a predetermined path between a first position and a second position; a first die element on the slide and having a forming surface against which a workpiece can be borne to conform the workpiece to the forming surface as the slide is moved from the first position towards the second position; and a knockout assembly comprising an ejecting element that is movable selectively relative to the first die element between extended and retracted positions, the ejecting element causing a workpiece conformed to the forming surface to be separated from the forming surface as an incident of the ejecting element moving from the retracted position into the extended position, the knockout assembly further comprising a knockout bar and at least a first knockout pin, the knockout bar movable relative to the slide between a retracted position and an extended position and causing the ejecting element to move from its retracted position into its extended position as an incident of the knockout bar moving from its retracted position into its extended position, the at least first knockout pin causing the knockout bar to be moved from its retracted position into its extended position as an incident of the slide moving from the second position into the first position, the first knockout pin having a first surface, and with the knockout bar in the retracted position and the slide in the second position, the first surface is spaced from the knockout bar a first distance, the first knockout pin and the knockout bar having an operative relationship, the method comprising the steps of:

selectively varying the operative relationship between the first knockout pin and the knockout bar by varying the first distance through a controller.

18. The method of operating a press system according to claim 17 further comprising the steps of generating signals indicative of the operative relationship between the first knockout pin and knockout bar and monitoring the operative relationship between the first knockout pin and the knockout bar through the signals.

19. The method of operating a press system according to claim 17 further comprising the steps of selecting a desired operative relationship between the first knockout pin and knockout bar through the controller, monitoring the operative relationship and producing signals indicative of the desired operative relationship, and through the controller processing the signals and in response thereto causing variation in the operative relationship between the first knockout pin and knockout bar necessary to maintain the desired operative relationship.

20. The method of operating a press system according to claim 19 further comprising the steps of selecting a desired operative relationship between the slide and the frame, monitoring the desired operative relationship between the slide and the frame and producing signals indicative of the operative relationship between the slide and the frame, and through the controller processing the signals indicative of the operative relationship between the slide and the frame and thereby causing any necessary variation in the operative relationship between the slide and the frame to maintain the desired operative relationship between the slide and the frame.

21. The method of operating a press system according to claim 17 further comprising the steps of monitoring an operative relationship between the slide and the frame and causing the production of signals to the controller indicative of the operative relationship between the slide and the frame.

22. The method of operating a press system according to claim 17 further comprising the steps of selecting a desired operative relationship between the slide and the frame, monitoring the operative relationship and producing signals indicative of the operative relationship, and through the controller processing the signals and thereby causing any necessary variation in the operative relationship between the slide and the frame to maintain the desired operative relationship between the slide and frame.

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